

MODERN HIGHWAYS IN MARYLAND

A Thesis Prepared for the  
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by

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### BEGINNING OF STATE ROAD CONSTRUCTION.

The advancement in the art of road building has been a measure of the development of the State of Maryland.

The progress of Maryland roads is divided into two main divisions, the Turnpike Era, and the era following the establishment of the State Roads Commission in 1908. The development of the Baltimore and Ohio Railroad brought about the end of the Turnpike Era, about 1850. From this time to the establishment of the State Roads Commission but little work was done on the highways in Maryland.

The history of the growth and decline of the Turnpike Era has been fully developed in a previous thesis entitled,

----- The History of Turnpike Roads in Maryland -----  
by H. D. Cashell.

so I will not dwell on this subject.

In 1898 an Act was passed by the General Assembly of Maryland, which authorized a Commission to see that a proper investigation was made of the conditions of the roads in the State, and of the best means of improving, constructing, and maintaining the same.

It was not until the State Roads Commission was established in 1908, that the State began to build and maintain modern highways. The history of the State Roads Commission has been fully covered in a thesis entitled,

----- Development of the State Roads Commission of Maryland ---  
by J.H. Bittner.

In 1910 the Assembly placed in the hands of the



Commission the control of all state road building. The Commission held public hearings in order to ascertain which roads the people desired to have improved as the beginning of the program. The result was that 1200 miles extending the length and breadth of the state were finally selected to be the nucleus of the State Highway System.

At this point an efficient engineering force became an absolute necessity if the Commission was to carry out the new and enlarged plan of road construction and maintenance, and with characteristic thoroughness they made their plans to develop the necessary skill.

#### FINANCIAL PROBLEM

The Act of 1908 by the Assembly authorized a bond issue of \$5,000,000, known as the State Road Fund, and the Act of 1910 made an additional loan of \$1,000,000. With this financial backing the Commission was ready to put the new plan into operation. It was decided to look into the condition of the turnpikes in order to determine their value in case of possible acquisition as a part of the State road system. It was, however, then and later determined that the Commission was not to proceed indiscriminately with the purchase of turnpikes, but only to acquire them where they were needed as a part of the State main artery system. The Commission recognized the desirability of abolishing the toll roads, but realized that if a system of modern roads was to be built, that its funds were not sufficient to purchase all or even a large part of the existing turnpikes.

The passage of the Automobile Law in 1910 provided

for a fund annually for the maintenance of both State Roads and State Aid Roads. The portion applicable to the State Roads was payable to the State Roads Commission, while that portion applicable to the State Aid Roads was payable on the certification of the Commission to the counties on drafts for expenditures which had been actually made in repairs on State Aid Roads.

#### CONSTRUCTION 1910-1911.

The methods and types of construction were of great variety and generally of a high type, including simple grading, drainage and bridging, sand-clay construction, shell macadam, gravel macadam, brick, stone block, sheet asphalt pavements, and some large concrete bridges.

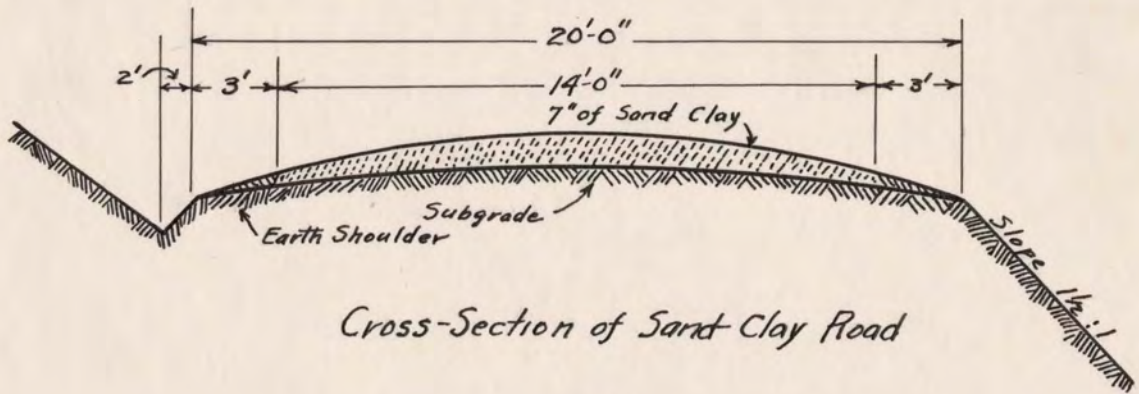
Modern and higher types of surfacing were required by changing traffic conditions, including the growth in the use of motor cars and trucks on the roads. These conditions were met by using higher standards of construction, such as wider macadam, the use of pitch in or on the surfacing, the installation of paved gutters to prevent washing, and the use of stone in the place of shells. The roads were built by contract, and were generally 14-feet to 16-feet wide.

In addition to the foregoing, the saving of old stone bridges and similar structures existing on the former turnpikes was begun. Many of these were important and valuable both physically and historically, but many had been allowed to become dangerously out of repair.

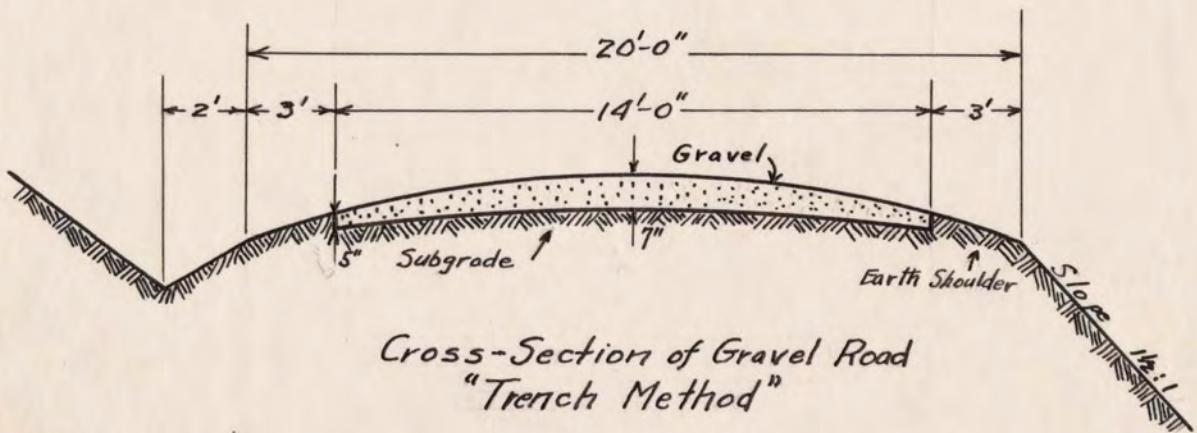
The use of bituminous materials to bind together macadam, sandstones, sand and shells was widely used in the con-



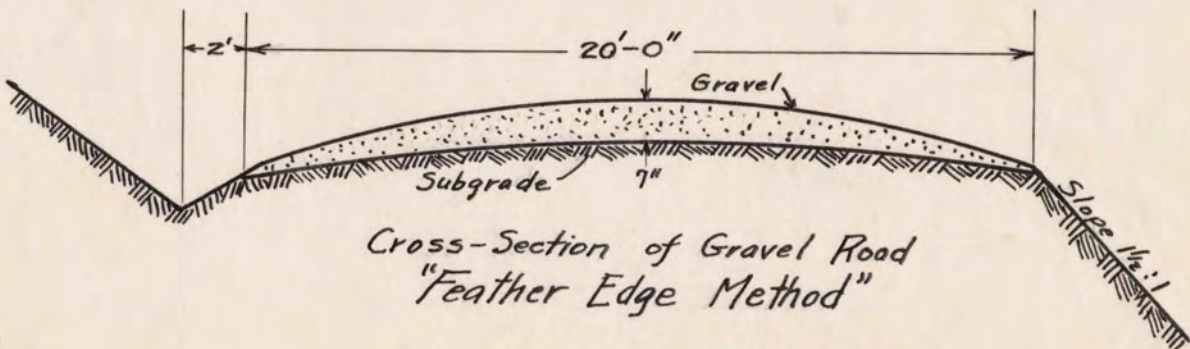
# Cross-Sections of Typical Roads



Cross-Section of Sand Clay Road



Cross-Section of Gravel Road  
"Trench Method"



Cross-Section of Gravel Road  
"Feather Edge Method"

struction of roads. The use of concrete as a base for bituminous macadam was contemplated by engineers, as the use of concrete for surfacing itself had not been satisfactory, owing to its tendency to crack, and the difficulty in remedying the defects. The work of the Commission in its use of bituminous materials in both construction and maintenance attracted much attention from other states, and even from abroad.

#### MAINTENANCE.

The importance and economy of prompt, efficient, and sufficient maintenance cannot be over estimated in road administration, and this is especially true in the case of modern roads.

The system of maintenance put into operation by the Commission in 1911 was the patrol system. This system assigns a stretch of road to each patrolman, and he is responsible for the upkeep of his section. It is his duty to make minor repairs such as filling ruts, holes, keeping the gutters and waterways clear, the brush and grass cut, and reporting all large repairs. This system gives the Commission an ideal agency through which to accumulate data of the character necessary for road design on a thorough engineering basis.

In 1912 the separate departments of construction and maintenance were consolidated into one, and the State was divided into eight geographical sections, each having a Resident Engineer.

The cost of maintaining macadam, gravel, sand-clay, and bituminous roads led to the investigation of a more substantial type of construction, namely, concrete. The first concrete roads were constructed in 1912, and from that time the use of



concrete has grown until today it is the most widely used material.

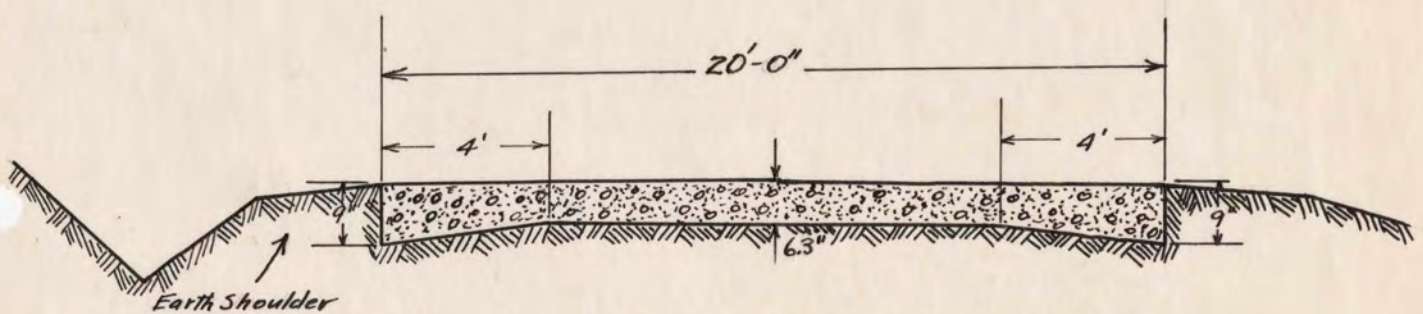
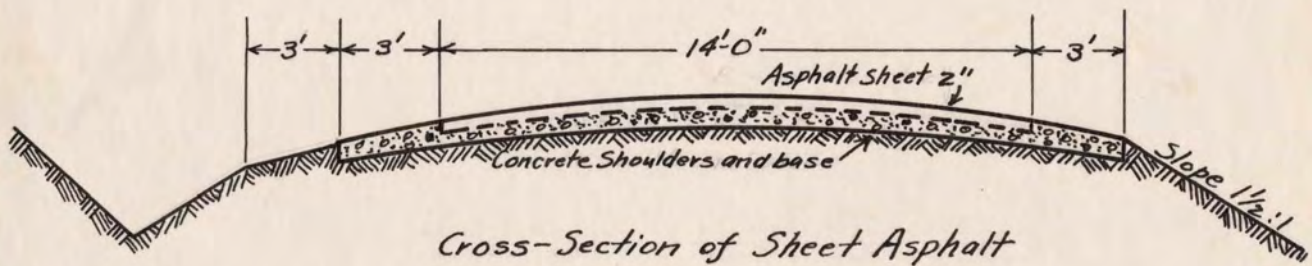
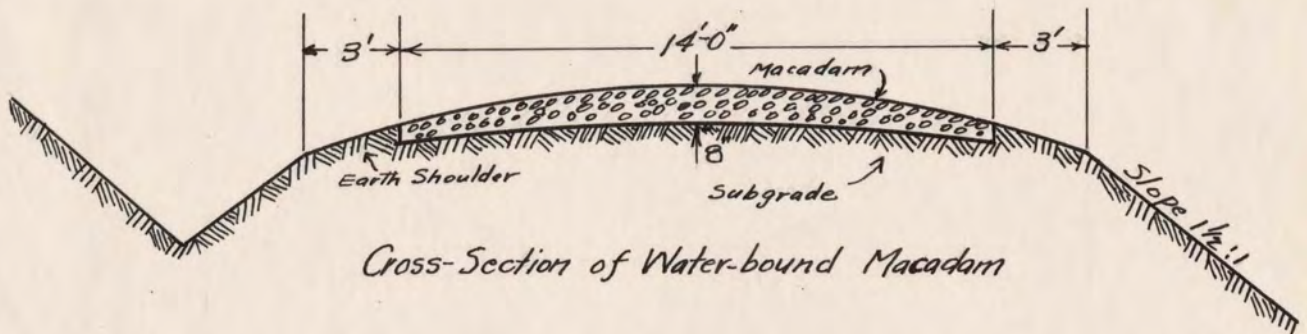
In concrete construction the road-bed must be prepared carefully, and the subgrade should be made accurately and nicely, because concrete is a monolithic substance, which, when set, cannot be changed except by removing. Rough and uneven subgrades were found to be costly to the contractors. Concrete construction is the best type of road, because it gives long life at low maintenance. By long life is meant from 10 to 20 years. When it reaches the point where it no longer can be economically maintained, it can be resurfaced with some form of hot mixed bituminous pavement to give another period of long life, thereby conserving the entire initial investment.

As the cost of road materials, labor, and freight had increased 20 to 40% since 1908, the Commission sought to offset this by discrimination in selecting types and methods of constructing roads, by shortening by relocation, eliminating curves, and by saving on the design. This was accomplished by the establishment of a Department of Surveys, in 1912, which had charge of all surveys, plans, estimates, test borings, soundings, and the testing of road materials. Standard plans were made for all bridges up to 36-foot spans, and on spans greater than this separate designs were worked up for each individual case.

#### OPERATIONS IN 1914-1915

The work was carried on during 1913 with little or no changes nor innovations. In 1914, in anticipation of a large volume of construction, the number of residencies in the State

## Cross-Sections of Typical Roads





was increased from eight to eleven. By dividing the State up into smaller units, each Resident Engineer was able to handle to better advantage the larger amount of work in his division.

Because of the heavy increase in traffic of all kinds, a greater proportion of concrete and bituminous roads were laid this year than in any year previous. Contracts included for the first time, the oiling of the roads, thereby increasing their cost by that amount, this having been previously charged to maintenance.

The first large bridge rebuilt by the Commission was the old timber bridge on Hanover Street in Baltimore, which had been in use since 1891. This was replaced in 1914 by a steel and reinforced concrete structure 8600-feet long with a rise of 45-feet, and a 50-foot roadway. It had 12 cantilever spans with a Rall-type, bascule bridge over the channel. This bridge was not only an engineering masterpiece, but it was architecturally perfect.

With the bridge building program under way, nine bridges were built during 1914, some serving to eliminate railroad grade crossings.

During this year the gang system of maintenance was established experimentally on several heavily traveled roads, replacing patrolmen in a number of places, but it was found that the period of time required for the gang, which consists of 6 or 7 men and a foreman, to pass from one end of the section to the other was so great that the repairs accumulating during this interval were more extensive than those which would have occurred under the patrol system.

In 1915 with the results of both the patrol system and gang system of maintenance at hand, the Commission decided to introduce the combined gang and patrol systems. This plan was put into operation, and is still used at the present time. One of the fundamentals of perfect maintenance is that construction and maintenance shall be under the same direction. The difference between Maryland and other States, is that in Maryland maintenance is continuous and precise.

#### THE MARYLAND METHOD

One of the difficulties experienced in the use of broken stone roads, was that heavy traffic crushed the stone, thereby weakening the surface. In 1915 the Commission resorted to a plan which they called the "Maryland Method", and which was entirely original. The practice of using 1/4-inch chips was abandoned, and 1-inch chips were used. The quantity of stone chips used per mile was increased this year, when they were rolled in for the first time. Oil was then added, about 1/2-gallon to the square yard, and the rolling squeezed the oil to the surface where it acted as a dust settler. It was found that this not only settled the dust, but added a substantial thickness to the surface of the road. This added expense of larger stone and oiling was found to be justified by the superior wearing surface obtained, and by this method much larger stone could be used to take care of heavier traffic.

Because of the large amount of work done during the previous year, the number of residencies in the State were reduced from eleven to eight. With the ending of 1915 the Commission had completed approximately 1000 miles of the system,



which as laid out comprised 1200-miles of roads.

#### PROGRESS 1916-1919

During the period from 1916 to 1919 a marked development in the type and width of construction, and of maintenance had taken place. This, like all other problems of maintenance and construction had been brought about by traffic, especially War traffic, during the years 1917 to 1919. Several of the main highways suffered most, due to this unusually large amount of heavy tonnage traffic. The roads were too light and too narrow, being only 14-feet wide, and the traffic too great in the number of vehicles, and heavy tonnage. This, together with the fact that frost had entered the subgrade for several feet, caused many failures. The repair work was so large that about  $\frac{2}{3}$  of the maintenance costs went for these repairs. This, in a measure, gives an idea of the damage directly due to increase in traffic during the War period. This experience brought about the fact that the roads must be widened and reinforced, due to the demands of the traffic. With this point in view, the roads were widened from a standard of 14-feet to as much as 22-feet, and increased in thickness from 7 and 5-inches to 8 and 6-inches respectively. Concrete shoulders were built along old macadam roads in such a way as to add 6-feet to the width of the road, and placed at such elevations as to reduce excessive crown, and permit the addition of an extra width of road along the edge of the concrete. This latter treatment has been tried with very successful results. It is further very practical, very efficient, and very economical in that the concrete shoulder is easily and quickly built under traffic. It also permits the addition of further width at the edge of the

the old road, the point where the latter is weakest and fails most frequent. It reduces excessive crown that marked considerable of the old types of construction, thus causing traffic to better distribute itself, and increasing the safety of travel. The method is convenient in that it permits traffic to use the road while under construction, with no more than ordinary hazard. It is further economical in that the metal itself costs little less than one-half the amount necessary to construct the metal alone in a new road of equal width, and is commendable because it takes advantage of construction already existing, on which there has been large expenditures.

In some cases sheet asphalt, 1-inch of binder and 1-1/2-inches of top course was placed on old macadam bases. Some of these roads were located in an industrial section that draws unusual heavy traffic, and while surfaced with macadam, was almost impossible to keep in repair. The sheet asphalt resurfacing eliminated the maintenance cost immediately, and there was nothing spent on this surfacing for over three years. Again, concrete roads which have failed have been surfaced with sheet asphalt, and at the same time widened by addition of cobble shoulders in a most satisfactory and economical way. All the methods just reviewed are rather ingenious, because they are both satisfactory and economical ways of taking care of ever increasing and perplexing maintenance problems by utilizing existing construction.

The maintenance throughout the State is carried on by the patrol system, augmented by gangs wherever the work is of such extent as to require the latter. Patrol sections vary in length from three to five miles, and patrolmen are allowed



helpers and teams at times. The size of the maintenance gang is controlled by the amount of work it has to do.

The widening and banking of curves on completed roads, and the removal of culvert walls on the inside of curves are necessary improvements which were begun in 1919.

During this period it was found necessary to revise the standard plans for culverts and bridges, to take care of the increased tonnage which they were forced to carry. With the War activities and the freight motor lines, it was found that the weight of many of these trucks when loaded, was in excess of the loads for which the early bridges were designed. For all pipe culverts and box culverts, having an opening of 3-feet or less, the clear width between the head walls was increased to 28-feet, which on all box, slab, and girder bridges from 3 to 32-feet spans, the widths between the walls or parapets were made 24-feet. Standard box culverts up to 5x5-feet; slab bridges with clear spans of 6 to 16-feet; and girder bridges with clear spans of 18 to 32-feet were redesigned to care for the maximum loads to which they were subjected, and care was taken to get the most economical proportions of concrete and steel possible.

Where a bridge of over 32-foot span was required, the standards provided for double or multiple spans, with the necessary piers, and provisions for expansion and contraction of the road slab. In cases where it was not practical to construct a bridge with a pier in the stream, special arches or other designs were made up to fit the conditions thus presented.

PERIOD FROM 1920 TO 1923

During this period many innovations and improvements were made by the Commission in the carrying out of their plan for modern highways. Maryland went a step beyond the passage of a motor vehicle law in 1920, she is actually enforcing it. When the State recently had to spend more than \$ 500,000. on the reconstruction and repairs of a large milage of the State highway system, which at this time comprised 1700 miles out of a total milage of 14,800 miles, damaged by excessively loaded motor trucks, after having been in service 7 to 10 years. It was decided to put into effect a policy which would definitely safeguard any further capital investments The result was the passage of a law limiting gross loads to 20,000 pounds, a much lower maximum than is allowed elsewhere.

Patrol crews with authority to stop and weigh trucks which are thought to be overloaded, were sent out. The width of tread was taken by running a wheel over a smooth steel plate on which an impression of the wheel track is secured by a piece of white paper; 650#/inch of width is the maximum allowable for solid tires. Since the establishment of this law, Mr. Mackall, Chairman and Chief Engineer of the Maryland State Roads Commission, reports that there has not been a single road failure.

Because of the high prices of materials and resulting bids there was very little construction done in 1920.

Except where it was very urgently needed, the maintenance fund excess was used to widen the roads in the interest of safety. Maryland's road system is undoubtedly the best in



the Union, but widening has improved it in many places.

----- Maryland State Roads Commission Report -----  
----- 1920 to 1923 ----- Page 14 -----

Not only will the widening materially reduce the cost of maintenance, but will actually save many lives and many dollars which would go in wrecked automobiles.

The necessity for widening existing roads is, the Commission feels, a tribute to, rather than a reflection upon, the system under which Maryland's roads have been built. By building the roads wide enough to care for the traffic expected to come in the immediate future, instead of traffic expected to come within, say, 15 or 20 years, the interest on additional expenditures is saved and the roads can be widened as widening becomes necessary; at no greater expense per mile than to have originally constructed to the greater width, and the interest on the additional capital charge is saved.

#### MODERN IMPROVEMENTS

The service which the roads are rendering to the people of Maryland and to those who use the roads, is much greater than was ever anticipated, so that details of maintenance not thought of a few years ago have become essential to the proper and efficient use of the highways. The removal of snow from the highways is certainly a service absolutely needed today, but undreamed of a few years ago. The proper marking of the highways for direction and distances is obviously essential to the use of the highways, but certainly even five years ago this could not have been considered as a function of road maintenance. Likewise, the widening of curves, banking, the surface markings to indicate the position automobiles

should take on curves, and at the top of grades, and the white-washing of telephone poles and obstructions as an aid to travel at night are a few of the things which the users of the road demand.

The Commission adopted the policy that in addition to the ordinary maintenance, special attention would be given and money expended to eliminate danger points on the roads and thus reduce accidents to a minimum. The scheme of painting a white stripe, 6-inches wide, down the center line of the road at all severe curves, and top of hills, was inaugurated and proved to be effective, as the traffic is thus assigned its right-of-way, and by keeping within it many accidents are avoided.

With a view to giving maximum service to the public, the Commission looked into the matter of sign-posting the highways. And in 1921 the Commission entered into a contract and completed the erection of direction and distance signs along the entire State Roads System.

There was realized a pressing need for danger and warning signs in addition to the direction and distance signs, so the Commission erected flashing lighthouse signals at all danger points. These are maintained without expense to the State Roads Commission by the advertising space carried on them. These proved eminently satisfactory and this practice was continued. The 500-foot safe sight distance was adhered to in designing all verticle curves. All obstructions along the way such as, telephone poles, culverts, rocks, and guard rails were white-washed so as to increase their visibility, thereby add-



ing an element of safety.

The first instance of expensive construction to abolish dangerous features on main highways, was the widening of Deadman's Curve on the Washington-Baltimore Boulevard, by the Maryland State Roads Commission at a cost of \$ 17,000. Now, no expense is spared to eliminate the element of danger from the highways, and make them safe and beautiful.

During this period one large bridge was undertaken. The Severn River Bridge was constructed of reinforced concrete on a timber pile foundation. The steel reinforcement of structural members was so designed as to eliminate the use of false-work. The length is 1850-feet, 24 spans of 65-feet each, and a bascule span of 75-feet with a 15-foot rise and a 22-foot roadway.

#### RESULTS OF THE COMMISSION'S OPERATIONS

It is easily seen that Maryland, since the establishment of the State Roads Commission in 1908, has made great strides in the construction and maintenance of a modern highway system. The Commission has made the roads modern, economical, and safe, until now she has a most modern and efficient highway system, rivalled, but not excelled, by that of any other State of the Union.

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